Claims

1. A method of adjusting a resonant cavity of a laser device, the laser device having a laser gain medium and an intracavity waveguide segment within a resonant cavity, the intracavity waveguide segment characterized by an effective refractive index profile, the resonant cavity characterized by a round trip optical length defining a free spectral range between adjacent longitudinal mode frequencies of said laser device, the method comprising:

operating the laser device to produce an optical output;

monitoring the optical output to determine the free spectral range of the laser device; and

permanently modifying the effective refractive index of at least a portion of the intracavity waveguide segment until said free spectral range substantially equals a predetermined rational fraction of a specified frequency channel spacing over a portion of an operating frequency band.

2. The method of claim 1 wherein permanently modifying said effective refractive index comprises illuminating said intracavity waveguide segment with an energy beam.

3. The method of claim 2 wherein said energy beam comprises electromagnetic radiation in the form of ultraviolet radiation and induces a chemical alteration in said intracavity waveguide segment.

4. The method of claim 2 wherein said intracavity wav guid segment further comprises a polymer structure and said electromagnetic radiation induces crosslinking in said polymer material.

5. The method of claim 1 wherein permanently modifying said effective refractive index comprises r moving material from a portion of said intracavity waveguide segment.

6. The method of claim 5 wherein said removing step further comprises the steps of:

projecting an energy beam onto said optical material, and

ablating said optical material.

7. The method of claim 1 wherein permanently modifying said effective refractive index comprises depositing effective refractive index modifying material onto said intracavity waveguide segment.

8. The method of claim 7 wherein said depositing step further comprises the steps of:

evaporating target material, and

directing said target material towards said intracavity waveguide segment.

9. The method of claim 8 wherein a mask is used to delimit the region of said intracavity waveguide segment exposed to said target material.

10. The method of claim 1 wherein said intracavity waveguide segment comprises a core characterized by a first refractive index and cladding around said core characterized by a second refractive index, optical energy from said laser gain medium propagating through said intracavity waveguide segment in both said core and at least a portion of said cladding, said first and

second refractive indices and a proportion of optical energy propagating in said cladding relative to said core determining a value of said effective refractive index of said intracavity waveguide segment, and wherein said modifying step comprises modifying at least one of said first and second refractive indices and said proportion.

11. The method of claim 10 wherein said cladding comprises a polymer structure.

12. The method of claim 1 wherein said round trip optical length is designed to differ from the optimal round trip optical length in a direction and by a mean amount that can be compensated by applying one of the processes of radiation exposure, material removal, or material deposition.

13. The method of claim 1 wherein said monitoring step includes determining at least one longitudinal mode frequency and said modifying step continues until at least a subset of the longitudinal mode frequencies coincide with said assigned channels.

14. The method of claim 1 wherein said modifying step is performed during the operating and monitoring steps.

15. The method of claim 1 further including the step of:

permanently modifying the effective refractive index of a second portion of the intracavity waveguide s gment to modify said free spectral range.

16. The method of claim 1 wherein the laser device further comprises a heater electrode adjacent to the intracavity waveguide segment, wherein the intracavity waveguide segment is thermo-optic, and wherein modifying said effective refractive index comprises heating said intracavity waveguide segment.

17. A method of adjusting a resonant cavity of a waveguide device, the waveguide device having an intracavity waveguide segment within a resonant cavity, the intracavity waveguide segment characterized by an effective refractive index profile, the resonant cavity characterized by a round trip optical length defining a free spectral range between adjacent longitudinal mode frequencies of said waveguide device, the method comprising:

illuminating the resonant cavity with diagnostic light to produce an optical output;

monitoring the optical output to determine the free spectral range of the waveguide device; and

permanently modifying the effective refractive index of at least a portion of the intracavity waveguide segment until said free spectral range substantially equals a predetermined rational fraction of a specified frequency channel spacing over a portion of an operating frequency band.

18. The method of claim 17 wherein permanently modifying said effective refractive index comprises illuminating said intracavity waveguide segment with an energy beam.

19. The method of claim 18 wherein said energy beam comprises electromagnetic radiation in the form of ultraviolet radiation and induces a chemical alteration in said intracavity waveguide segment.

20. The method of claim 18 wherein said intracavity waveguide segment further comprises a polymer structure and said electromagnetic radiation induces crosslinking in said polymer material.

21. The method of claim 17 wherein permanently modifying said effective refractive index comprises removing material from a portion of said intracavity waveguide segment.

22. The method of claim 21 wherein said removing step further comprises the steps of:

projecting an energy beam onto said optical material, and

ablating said optical material.

23. The method of claim 17 wherein permanently modifying said effective refractive index comprises depositing effective refractive index modifying material onto said intracavity waveguide segment.

24. The method of claim 23 wherein said depositing step further comprises the steps of:

evaporating target material, and

directing said target material towards said intracavity waveguide segment.

25. The method of claim 24 wherein a mask is used to delimit the region of said intracavity waveguide segment exposed to said target material.

26. The method of claim 17 wherein said round trip optical length is designed to differ from the optimal round trip optical length in a direction and by a mean amount that can be compensated by applying one of the processes of radiation exposure, material removal, or material deposition.

27. The method of claim 17 wherein said monitoring step includes determining at least one longitudinal mode frequency and said modifying step continues until at least a subset of the longitudinal mode frequencies coincide with said assigned channels.

28. The method of claim 17 wherein said modifying step is performed during the operating and monitoring steps.

29. The method of claim 17 further including the step of:

permanently modifying the effective refractive index of a second portion of the intracavity waveguide segment to modify said free spectral range.

30. The method of claim 17 wherein said illuminating step further comprises the steps of:

operating a light source and

coupling diagnostic light produced by the source into said intracavity waveguide segment.

31. The method of claim 30 wherein said light source is a tunable single frequency laser and wher in said illuminating step further comprises the step of:

tuning a frequency of the diagnostic light.

32. The method of claim 30 wherein said light source is a broad band light source and wherein said monitoring step further comprises the step of:

determining the spectrum of said optical output.

33. The method of claim 30 wherein said coupling is performed at an index grating traversed by optical energy propagating through said intracavity waveguide segment and wherein said illuminating step further comprises the step of:

phase matching said grating for coupling an optical frequency of said light source into a longitudinal mode of said resonant cavity.

34. The method of claim 33 further comprising the step of:

actuating a heater element disposed adjacent to said index grating.

35. The method of claim 17 wherein the waveguide device further comprises a heater electrode adjacent to the intracavity waveguide segment, wherein the intracavity waveguide segment is thermo-optic, and wherein modifying said effective refractive index comprises heating said intracavity waveguide segment.

36. A method of adjusting a resonant cavity of a waveguide device, the device having an intracavity waveguide segment within a resonant cavity and a coupling waveguide segment coupled to the intracavity waveguide in a first coupling region, said coupling characterized by a first frequency dependent coupling constant, said resonant cavity characterized by a round trip optical loss, the method comprising:

illuminating the coupling waveguide segment with light to pass optical energy through the first coupling region;

monitoring optical energy throughput that passes through the first coupling region in the coupling waveguide segment;

permanently modifying a characteristic of said intracavity waveguide segment said resonant cavity until said throughput drops below a predetermined tolerance at a specified frequency.

37. The method of claim 36 wherein said modifying step comprises modifying the first coupling constant.

38. The method of claim 37 wherein the step of modifying the first coupling constant further comprises:

irradiating at least a portion of the first coupling region with an energy beam.

39. The method of claim 38 wherein said energy beam comprises electromagnetic radiation in the form of ultraviolet radiation and wherein said irradiating step induces a chemical alteration in said intracavity waveguide segment and modifies an index of refraction.

40. The method of claim 38 wherein at least one of said intracavity and said coupling waveguide segments comprises a polymer structure and said energy beam induces crosslinking in said polymer material.

41. The method of claim 38 wherein said energy beam comprises an ultraviolet laser beam and wherein said irradiating step ablates material from at least a portion of the first coupling region.

42. The method of claim 36 wherein said modifying step comprises modifying the round trip optical loss.

43. The method of claim 42 wherein said resonant cavity further comprises a metallic film that contributes to the optical loss in the resonant cavity, and wherein the step of modifying the round trip optical loss further comprises the step of:

removing at least a portion of the metallic film to reduce the round trip optical loss.

44. The method of claim 43 wherein said removing step is a laser ablation step.

45. The method of claim 42 wherein the step of modifying the round trip optical loss further comprises the step of:

irradiating said intracavity waveguide segment with an energy beam to change an index of refraction.

46. The method of claim 45 wherein said irradiating step forms an index of refraction interface transverse of said intracavity waveguide segment, said interface redirecting a portion of the optical power propagating along the intracavity waveguide segment, thereby increasing the round trip optical loss.

47. The m thod of claim 42 wherein said resonant cavity further comprises a second coupling region characterized by a second frequency dependent coupling constant, and wherein said step of modifying the round trip optical loss further comprises the step of:

modifying the second coupling constant to modify the fraction of optical power coupled out of the resonator at said second coupling region.

48. The method of claim 47 wherein said modifying step further comprises:

irradiating at least a portion of the second coupling region with an energy beam.

49. The method of claim 36 wherein said modifying step comprises the steps of:

exposing said waveguide device in said coupling region with a spatially modulated energy beam to produce an index grating and,

adjusting the exposure to modify the strength of the index grating.

50. The method of claim 49 wherein said spatially modulated energy beam is an electromagnetic beam of ultraviolet light passed through a phase mask and said exposure is a time integrated optical intensity.

51. The method of claim 49 wherein said spatially modulated energy beam is a plasma beam of ions passed through a patterned mask layer and said exposure is a tim integrated particle flux.

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